

Application Serial No. 10/060,561
Attorney Docket No. VI/99-020

Amendments to the Claims:

The following listing of claims, in which claims 9, 22, 23 and 39 are currently amended and claims 28-30 are currently canceled, replaces all prior versions, and listings, of claims in the application:

1-6. (Canceled)

7. (Previously Presented) An apparatus for the detection of extravasation, comprising:

at least a first energy source adapted to supply X-ray energy or gamma ray energy to tissue in the vicinity of a site along a path of potential extravasation of fluid from a blood vessel into which fluid is injected;

at least a first sensor to measure a signal resulting from the energy supplied to the tissue by the first energy source, the signal being proportional to the X-ray energy or gamma ray energy transformed, reflected, scattered or absorbed by an extravasated fluid present in the vicinity of the site; and

an indicator to provide an indication of the occurrence of extravasation.

8. (Previously Presented) The apparatus of claim 7 wherein the at least a first energy source and the at least a first sensor are connected by a frame member to fix the geometry of the at least a first energy source and the at least a first sensor about the site so the X-ray energy from the at least a first energy source passes through tissue in the vicinity of the site to the at least a first sensor.

9. (Currently Amended) The apparatus of claim 7, ~~further comprising wherein the~~ indicator comprises an alarm to indicate the occurrence of extravasation.

10. (Original) The apparatus of claim 9 wherein an alarm is indicated if the energy measured at the at least a first sensor falls below a threshold value.

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11. (Previously Presented) An apparatus for the detection of extravasation, comprising:

at least a first energy source adapted to supply ultrasonic energy to tissue in the vicinity of a site along a path of potential extravasation of fluid from a blood vessel into which fluid is injected;

at least a first sensor to measure a signal resulting from the energy supplied to the tissue by the first energy source, the signal being proportional to the ultrasonic energy reflected, scattered or absorbed by an extravasated fluid present in the vicinity of the site; and

an indicator to provide an indication of the occurrence of extravasation.

12. (Previously Presented) The apparatus of claim 11, wherein the indicator comprises an alarm system to indicate the occurrence of extravasation.

13. (Original) The apparatus of claim 12 wherein the occurrence of extravasation is determined by comparing the energy measured at the at least a first sensor to a threshold value.

14-15. (Canceled)

16. (Previously Presented) A method for detecting extravasation in an injection procedure, comprising:

supplying at least one of X-ray energy, gamma ray energy or ultrasonic energy to tissue in the vicinity of a site along a path of potential extravasation of fluid from a blood vessel into which fluid is injected;

measuring a signal resulting from the energy supplied to the tissue, the measured signal being proportional to the X-ray energy, gamma ray energy or ultrasonic energy transformed, reflected, scattered or absorbed by an extravasated fluid present in the vicinity of the site; and

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analyzing the measured signal to determine whether an extravasated fluid is present in the vicinity of the site.

17. (Original) The method of Claim 16, further comprising:

measuring a baseline signal before beginning the injection procedure.

18. (Previously Presented) An injection system comprising:

a powered injector; and

an extravasation detection apparatus comprising:

at least one source of energy to supply at least one of x-ray energy, gamma ray energy, or ultrasonic energy to tissue in the vicinity of a site along a path of potential extravasation of fluid from a blood vessel into which fluid is injected;

at least one sensor to measure a signal resulting from the energy supplied to the tissue in the vicinity of the site, the signal being proportional to the x-ray energy, gamma ray energy or ultrasonic energy transformed, reflected, scattered or absorbed by an extravasated fluid present in the vicinity of the site; and

an indicator to provide an indication of the occurrence of extravasation.

19. (Previously Presented) The apparatus of claim 18, wherein the indicator comprises an alarm in communication with the extravasation detection apparatus to indicate occurrence of extravasation.

20. (Original) The apparatus of claim 18 wherein the injector and the extravasation detection apparatus are in communicative connection so that an injection procedure is stopped by the injector upon detection of extravasation.

21. (Original) The apparatus of claim 19 wherein the alarm indicates extravasation based upon comparing the signal to a threshold value.

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22. (Currently Amended) A method for detecting extravasation in an injection procedure, comprising:

supplying x-ray energy, gamma ray energy or ultrasonic energy to tissue in the vicinity of an injection site along a path of potential fluid extravasation from a blood vessel into which contrast medium is injected;

measuring a baseline signal resulting from the energy supplied to the tissue;

mixing an additive with a contrast medium;

injecting the contrast medium containing the additive through the injection site into the blood vessel;

supplying x-ray energy, gamma ray energy or ultrasonic energy to tissue in the vicinity of the injection site;

measuring a signal resulting from the energy supplied to the tissue, the measured signal being proportional to the X-ray energy, gamma ray energy or ultrasonic energy transformed, reflected, scattered or absorbed by extravasated contrast medium containing the additive present in the vicinity of the site, the additive being adapted to affect the signal;

~~supplying energy to tissue in the vicinity of a site along path of potential extravasation of fluid from a blood vessel into which contrast medium is injected; and~~

~~measuring a signal resulting from the energy supplied to the tissue to determine if extravasation has occurred, the energy being of a different type than imaging energy adapted to be used in connection with the contrast medium, the additive being adapted to affect the signal~~

detecting whether an extravasation has occurred by comparing the measured signal to the baseline signal to determine whether extravasated contrast medium containing the additive is present in the vicinity of the site; and

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indicating that an extravasation has occurred.

23. (Currently Amended) A method of detecting extravasation of an injection medium, comprising:

supplying x-ray energy, gamma ray energy or ultrasonic energy to tissue in the vicinity of a site along a path of potential extravasation of fluid from a blood vessel into which injection medium is injected, the energy being selected so that the injection medium will reflect, scatter or absorb the energy; [[and]]

measuring a signal proportional to the amount of energy reflected, scattered or absorbed;

detecting whether an extravasation has occurred by analyzing the measured signal to determine whether extravasated medium is present in the vicinity of the site; and

indicating that an extravasation has occurred.

24. (Original) The method of Claim 23, further comprising:

measuring a baseline signal corresponding to a situation in which there is no extravasation.

25-26. (Canceled)

27. (Previously Presented) The method of Claim 17, further comprising:

comparing the measured signal to the baseline signal to determine whether an extravasated fluid is present in the vicinity of the site.

28-30. (Canceled)

31. (Previously Presented) The method of Claim 23, further comprising:

analyzing the measured signal to determine whether an extravasated fluid is present in the vicinity of the site.

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32. (Previously Presented) The method of Claim 24, further comprising:

comparing the measured signal to the baseline signal to determine whether an extravasated fluid is present in the vicinity of the site.

33. (Previously Presented) The apparatus of Claim 7 wherein the first energy source and the first sensor do not contact the skin of a patient.

34. (Previously Presented) The apparatus of Claim 7 wherein the first energy source and the first sensor are positioned in a manner so that the vicinity of an injection site is available for palpation and visible for visual inspection.

35. (Previously Presented) The apparatus of Claim 11 wherein the first energy source and the first sensor do not contact the skin of a patient.

36. (Previously Presented) The apparatus of Claim 11 wherein the first energy source and the first sensor are positioned in a manner so that the vicinity of an injection site is available for palpation and visible for visual inspection.

37. (Previously Presented) The injection system of Claim 18 wherein the energy source and the sensor do not contact the skin of a patient.

38. (Previously Presented) The injection system of Claim 18 wherein the energy source and the sensor are positioned in a manner so that the vicinity of an injection site is available for palpation and visible for visual inspection.

39. (Currently Amended) An injection system for delivering fluid to a patient during an injection procedure, the injection system comprising:

an injector; and

an extravasation detection system in communication with the injector, the extravasation detection system comprising:

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an energy source adapted to supply at least one of x-ray energy, gamma ray energy, or ultrasonic energy to tissue of the patient in the vicinity of a fluid injection site; [[and]]

a sensor adapted to measure a signal resulting from the energy supplied to the tissue in the vicinity of the fluid injection site, the signal being proportional to the x-ray energy, gamma ray energy or ultrasonic energy transformed, reflected, scattered or absorbed by an extravasated fluid present in the vicinity of the fluid injection site; and

an alarm to provide an indication of the occurrence of extravasation;

wherein the ~~injection procedure is terminated~~ alarm is activated when an extravasated fluid is detected by the extravasation detection system.

40. (Previously Presented) A method for detecting extravasation during a fluid injection procedure, comprising:

supplying x-ray energy, gamma ray energy or ultrasonic energy to tissue in the vicinity of a proposed fluid injection site;

measuring a baseline signal resulting from the energy supplied to the tissue;

commencing the fluid injection procedure;

supplying x-ray energy, gamma ray energy or ultrasonic energy to tissue in the vicinity of the fluid injection site;

measuring a signal resulting from the energy supplied to the tissue, the measured signal being proportional to the X-ray energy, gamma ray energy or ultrasonic energy transformed, reflected, scattered or absorbed by an extravasated fluid present in the vicinity of the site; and

comparing the measured signal to the baseline signal to determine whether an extravasated fluid is present in the vicinity of the site.

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41. (Previously Presented) The method of Claim 40, further comprising:

terminating the injection procedure if an extravasated fluid is present.